Vol. XI. No. 3. March 15, 1914

THE PSYCHOLOGICAL BULLETIN

GENERAL REVIEWS AND SUMMARIES

VISION—GENERAL PHENOMENA

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The little-heard-of color-theory of Zenker has been redescribed, with critical comments, by Minkowski (**21**). Zenker's view is that the light which reaches the retina is reflected by systems of thin plates which make up the ends of the rods and cones, the oncoming and the reflected rays produce by interference standing waves whose crests lie at different distances from the reflecting surfaces according to the wave-length of the rays in question. The nervous substance in different layers of the retina will then be stimulated photo-chemically by different wave-lengths, and thus tissues of different "specific energies" lying in the different layers of the retina will always be affected by certain specific wave-lengths of light. For the rest the theory rests on Müller's theory of specific energies. In some careful work on the cephalopod eye Fröhlich (**12**) finds evidence that the visual "specific energy" is a matter of the periodicity of the nerve-impulse. With the Einthoven galvanometer Fröhlich found that the action-currents of this eye, which is virtually a rod-eye, exhibit periodic fluctuations varying from 20 to 90 times per sec. under various conditions. The frequency and intensity of the rhythm increase with the intensity of the illumination (stimulus); they also vary with the wave-length of the stimulating light. There is also an after-rhythm whose frequency and intensity depend on the wave-length of the preceding stimulus: this is the basis of after-images, which are thus not a fatigue phenomenon (cf. Homuth, **16**). But light-adaptation is a fatigue phenomenon, and the light-adapted eye reacts with less intense and

less frequent nerve-impulses. Blue-violet light has the highest stimulating, and fatiguing, power: and accordingly in the light-adapted eye the blue-violet light has lost most efficiency and the maximum brightness point of the spectrum has moved toward the red end (Purkinje phenomenon). The frequencies of the nerve-impulse were found to be for red, 20–40 per sec.: for blue, 40–60: for white, 60–90. "These excitations produce in the central nervous-system antagonistic processes, excitation or inhibition. This excitation, as well as the inhibition, can be strong or weak, and they are to be looked on as the physiological basis of color-sensation." Interesting in this connection is the paper of Sivén (**26**) who presents a series of facts to show that the "rods are the organs which are concerned in the perception of color of short wave-lengths." The von Kries duplex theory "can no longer be upheld." At any rate the facts cited by Sivén deserve attention. Lasareff (**18**) gives an "ionic theory" of rod-vision based on "Loeb's law." In rod-vision at the threshold the stimulating value of a stimulus of any color is equal to the amount of energy absorbed by the visual purple. In another paper (**17**) Lasareff reports that if two visual stimuli having a given intensity-difference are presented in rhythmical alternation, the period of alternation can be so selected that the given intensity-difference shall be a just-perceptible difference. This period is found to be a linear function of $\Delta j/j$, where j equals the intensity of the stimulus. Or, $\Delta j = kj/n$ where Δj is the just observable difference, j the intensity of the light, k a constant, and n the number of intensity alternations per second. Lasareff further gives (**19**) a mathematical formula for the relation between light intensity, area stimulated, etc., and the resultant sensation ("stimulation value"). Exception will perhaps be taken, on empirical grounds, to some of the assumptions on which he bases the formula.

For normal eyes Borchardt (**3**) finds that the threshold value of illumination is fairly constant when the area stimulated subtends a visual angle of 7° or over. As the visual angle varies from 1° to 7° the threshold stimulus rapidly decreases in both central and peripheral fields. The periphery (60° from fovea) is about twice as sensitive as the central field. This paper is in harmony with that of Blachowski (**2**) only on the supposition that "*Binnenkontrast*" is not an appreciable factor at threshold intensities. *Binnenkontrast* (Abney's "extinction of light") is the depressing effect exercised by one retinal element on the sensations from neighboring and simultaneously stimulated elements. Blachowski studies this

phenomenon by comparing the threshold values of very small areas when superimposed on small and large stimulated areas, respectively. As the background area increases, the threshold illumination of the small, superimposed patch decreases. There may be some question as to the interpretation of this result, since it remains true that the total stimulation of the *just-perceptible* superimposed area is *less* when the illuminated background is large than when it is small. The paper contains interesting collateral discussions, especially in regard to Hering's "color constancy of visual objects." The author finds a *Binnenkontrast* for both white-black and color. Hermann studies an analogous phenomenon (15). Two colored fields are viewed simultaneously on a light (*H*) and a dark (*D*) gray background, respectively. Owing to "black induction" from the light ground (*H*) the colored field thereon (*Hc*) looks darker than the other colored field (*Dc*). White light is now added to *Hc* until *Hc* = *Dc*. But now *Hc* looks less saturated than *Dc:* accordingly color is now added to *Hc* until again *Hc* = *Dc* (*now* both in intensity and saturation). Hermann finds now that the ratio of the *total* amount of color in *Hc* to that in *Dc* (Révész) increases as a linear function of the brightness of the *H* background. Superficially at least these results seem hardly reconcilable with those of Blachowski. Comparison of the two papers (2 and 15) seems to present an interesting problem. Cobb and Geissler (4) study the effect of dark and light surrounding fields on (1) difference discrimination and (2) visual acuity, in the central field of vision. The dark field used was practically a physical absence of light. "For [test] objects of relatively low brightness, the presence of a surrounding field of relatively high brightness has the effect of lowering the capacity of vision" for both (1) and (2). "In the case where the surrounding field was slightly brighter than the test-object visual discrimination was found to be actually better" for both (1) and (2) "than for a physically identical object seen in dark surroundings." Similarly Cobb (5) finds that "the bright surroundings are seen in all cases to cause more or less extreme loss in visual discrimination when the test-object is observed at a brightness much less than that of the surroundings." "Bright surroundings which are not brighter than the test-object itself result in slightly better vision [acuity] than the dark surroundings." The judgments on (1) *fluctuate* least when the test-object is of equal brightness with the surroundings: and there is some evidence that here also the difference-threshold itself tends to be lowest. Baird, in (1), corrects some misstatements and

unwarranted assumptions that have been published by Ferree and Rand in their discussions of colored after-images from subliminally colored stimuli, and in connection with some topics similar to those investigated by Cobb and Geissler.

Geissler (13) inquires "whether the number and sizes of colored stimulus-increments corresponding to just noticeable saturation differences would lend themselves to a measure of saturation." For the color red he finds that the stimulus-differences corresponding to just-noticeable saturation-differences are approximately equal through a considerable range, and especially for the lower saturations used. The author deems his results to be tentative, but it appears not unlikely that the difference limens for saturations will be found to be absolutely (not relatively) equal. Pauli (23) gives interesting data on the specific judgment of brightness (heterochrome). White and yellow or yellow and green are easy to compare as to brightness; white and green are harder; red and yellow, and blue and yellow are the hardest. In the more difficult comparisons the colors are felt to present other than chromatic differences—differences which are hard even to name. Homuth's study of after-images (16) is too detailed to be adequately summarized. The "flight of colors" is described and interestingly commented on. *Randkontrast* is distinguished from *Flächen-* or diffuse contrast: the latter is not so distinctly a complementary phenomenon. The after-image, whether positive or negative, is not a fatigue phenomenon and is a process independent of any reacting field of light (both these in agreement with Fröhlich 12). The "flight of colors" is not a fatigue phenomenon, but a case of rivalry between idio-retinal light and the after-image optogramme, which latter includes the stimulations set up in the several fundamental color-processes. Homuth propounds yellow, blue, and purple as the three primary color-processes, and discusses this theory at some length (pp. 228–236). Edridge-Green (8) likewise argues, from various after-image phenomena, that yellow is a simple and physiologically fundamental sensation. The same author contends (9) that there is "a continual flow of photochemical liquid from the periphery to the center of the retina." This accounts for the lack of definition of after-images, for their liability to wander, coalesce, etc., etc. Schulz (24) studies the effect of santonin poisoning on the ability to discriminate as "darker" or "lighter" two violet (or yellow, or red, etc.) stimuli. Very interesting curves are obtained but, in the reviewer's opinion, the employment of "darker-lighter" judgments

in order to study yellow- and violet-vision was ill-judged. "Santonin (yellow) vision" is accompanied by decreased ("light-dark") sensitiveness to violet. Before this stage comes on, and very shortly after the santonin is ingested, there is a brief phase of decreased sensitiveness to yellow and of increased sensitiveness to violet. In (**25**) Schulz studies in a similar way the effect of digitalis on the seeing of green. Arndt's "biological law" is confirmed.

Parker and Patten (**22**) find that continuous illumination of the eye is physiologically more effective than interrupted illumination. When two lights, an intermittent and a continuous, were equated for normal vision, the former was shown by the radiomicrometer to be physically 5.9 per cent. more intense than the latter. Differing rates of intermission, between 540 and 2,950 per minute, did not significantly change this figure. Mallock (**20**) finds that the illusion of seeing as if at rest the spokes of the wheels of a moving automobile is due to some jar to the head or nervous system (as in walking). Under experimental conditions so slight a jar as that occasioned by winking the eye sufficed to produce this intermittence of vision. The theory offered by Mallock to explain the phenomenon is undoubtedly inadequate. Groos (**14**) refers to a very similar cause some subjective illuminations of the visual field which are often observed during earthquakes. Ferree (**10**) attributes the fluctuating appearance and disappearance of liminal visual stimuli of point area to "adaptation," *i. e.*, "the progressive loss of sensitivity to colored and colorless light caused by prolonged exposure of the eye to these lights." The eye becomes "adapted" to the small stimulus until it no longer sees it, and then a small involuntary eye-movement comes in to bring the stimulus on a fresh part of the retina, and the stimulus is again seen, while the "adapted" part of the retina has time to recover; and so on. Agreeably to his usual method the author undertakes to establish the utter imbecility and incompetence of those investigators who, prior to himself, have ventured to study the same problem.

Trendelenburg (**27**) was able to obtain binocular mixture of spectral colors, without configuration of the field, by reducing the size of the stimuli to a visual angle of 30 minutes; rivalry was thus very largely done away with. Trendelenburg finds that in binocular mixtures less of the shorter-waved component is required than is required in monocular mixtures to produce the same hue. It is less certain, however, that this is true when complementary color-pairs are being mixed. Dawson (**6**) finds that small intensity dif-

ferences are more accurately, rapidly, and confidently discriminated by two eyes than by one. He believes this to be due neither to the lack of practice in uniocular discrimination, nor to a summation of brightnesses in binocular vision; but to the circumstance that the binocular image fluctuates less than the uniocular, and so gives a steadier basis for judgment. Each eye's image is subject to fluctuation, but the two images do not fluctuate synchronously, and therefore the binocular image is steadier than either uniocular. Filehne (11) aims to explain why on a cloudy day a snow-covered landscape looks whiter and brighter than the clouded sky, which although really brighter looks gray and darker. The author shows that on looking at the sky the eye becomes relatively light-adapted; on looking at the snow, relatively dark-adapted. Now the light on the snow is more uniformly distributed (as to shadows, etc.) than it is in the sky (!): therefore when the eye looks at the sky not only is light cut off by the diminished pupils and made ineffective by the light-adapted retina, but also the cloud masses look very dark by contrast with the unclouded spaces. Dufour and Verain (7) describe an experimental arrangement similar to that for Ragona Scinà's experiment.

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VISION—PERIPHERAL AND FOVEAL

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Very little work has been done in this field during the past year. Werner (6) studies the influence of the blind spot on the spatial values of the visual field. Eleven figures are in turn so placed in the field of vision that the blind spot falls closely within their margins. In each case the observer reports distortion of form and decrease in size. Werner concludes against the doctrine of "associative filling-in." Hoppe (2) describes an unusual visual phenomenon which he believes to be due to some action of strong light

on cells of the retina not usually regarded as sensitive to light. The conditions for obtaining the phenomenon are long adaptation to strong diffuse daylight, 2 minutes in the dark-room, and a return to the daylight illumination. The appearance is of a star-shaped pattern concentric to the fixation-point. At a projection distance of 1 meter the pattern covers an area 15 cm. in diameter. Perlmann (3) reports a case of sympathetic amblyopia which has been under his observation since 1910. The report is made in part because doubt has recently been expressed that the phenomenon exists. Beauvieux and Delorme (1) investigate the disturbances in light and color sensitivity for 71 cases of chronic glaucoma to find out whether these as well as the narrowing of the visual field may not have a diagnostic value. They conclude that the disturbances obey no characteristic law and have, therefore, no diagnostic value. Vogt (5) describes a successful method of demonstrating the yellow coloration of the macula by ophthalmoscopic examination. A successful demonstration seems to depend on getting light of the right composition. All red rays must be eliminated, for they only emphasize the natural redness of the fundus and give an unfavorable background for the discrimination. The light must be freed also from all violet, ultra-violet, and indigo rays, for these cause an obscuring fluorescent action of the lens. The best light is a mixture of pure blue and yellow. Vogt uses with success in a projection lantern light filters which transmit the spectrum from $620\mu\mu$–$420\mu\mu$ with the maximum of transmission in the yellow and cyan blue. When this light is thrown into the eye by means of an ophthalmoscope the macula shows a strong yellow coloration. This light is of excellent quality, moreover, for the general ophthalmoscopic examination of the retina. Rand (4) reports a quantitative study of the factors that influence the sensitivity of the retina to color and works out methods of standardizing these factors. She was led to undertake this study because of the inability, generally recognized, of obtaining reproducible results in the work of determining the sensitivity of the retina to color, more especially of the peripheral retina. The factors influencing the sensitivity to color may be divided into two classes: (1) those pertaining to the stimulus or source of light; and (2) those extraneous to the stimulus. To the latter class belong the effect of preëxposure, the brightness of the surrounding field, and the intensity and constancy of the illumination of the field of vision. In previous work the effect of the last two of these factors has been recognized, but no systematic

quantitative study of their influence has been made and no adequate means of standardizing their effect has been devised. The pre-exposure and surrounding field, for example, should be of a gray of the brightness of the color for the conditions under which the observation is made; and the general illumination of the field of vision should not only be maintained constant, but there should be such a specification of this illumination on every point that influences the results of the investigation that the conditions of work may be fully understood and duplicated. Under the factors pertaining to the stimulus, we find size of stimulus or visual angle, and the composition, amount, and white-value of the colored light employed. Of these factors size of stimulus has been adequately treated and in some cases also the composition of the light employed. No adequate specification, however, has been made of the amount or intensity of light used;[1] and no account has been taken of the relative amounts

[1] Since the specification of amount of light is purely a physical procedure, Rand advocates the adoption of the method used by the physicists for this purpose, namely a specification in terms of energy or C.G.S. units. The inadequacy and difficulty of a photometric specification of colored light is discussed at length. Relative amounts or energies of colorless lights, for example, estimated in terms of some known standard may be specified by photometric methods; but relative amounts of colored light can not be so specified in terms of known colorless standards because equal amounts of colored and colorless lights do not arouse equal luminosities in sensation. The specification can be made only in terms of power to arouse the colorless component in sensation.

A similar attitude is taken towards the terms that are used in the specification of the stimulus. Since the stimulus is purely a physical quantity, the author favors the adoption of the terminology of the physicist for this purpose. She points out that any other course tends to produce needless confusion, especially in the overlapping fields of physical and psychological optics. In the writings of Landolt and Abney (a physicist), Baird, for example, interprets *intensity* as applied to colored light to mean white-value, and ascribes the variations they get in the limits of sensitivity to variations in the white-value of the stimulus, when what is actually varied in their experiments was the total amount of colored light coming to the eye. In this way he gets authority from the writings of these men for equating the stimuli in white-value for making a determination of the comparative limits of sensitivity. In her own work Rand used intensity in accord with the physicist's definition of the term, namely, the amount or energy per unit of area and unit of time at the point considered.

In fact, Abney and his collaborator Watson have made a specific statement of what Abney means by the term intensity in all his work. Watson (Proceedings of the Royal Society, 1913, **88**A, 404–405) after stating that luminosity and intensity are used interchangeably, says: "The physical brightness of a light, i. e., the stimulus, will be spoken of as the intensity, the term brightness being reserved for the sensation produced when the light enters the eye. . . . The above definition of what is meant by the luminosity of a color in the spectrum of a given source is equivalent to that employed by Sir William Abney in all his work." Abney (see W. de W. Abney

employed in making comparative determinations of sensitivity to different colors.[1] Some attempt, though, has been made at a subjective regulation. Bull, Hess, Hegg, and Baird, for example, equated their stimuli in terms of the cancelling proportions of the antagonistic colors for a determination of the comparative limits of sensitivity to these colors. This procedure is characterized by Dr. Rand as an anomaly in methods of standardizing, arising probably from doctrinal rather than experimental considerations.[2]

and W. Watson, *ibid*, 1913, 89A, 233) sanctions this definition in the following words: "An explanation of what is meant by the luminosity of a colored light is given on p. 404 of Vol. 88 (A, 1913) of the Proceedings."

[1] The author assumes no responsibility for creating the problem of determining the comparative sensitivity of the retina to lights of different color, but she contends that if such a comparison is to be made, account should be taken in making the comparison of the amounts of light used in each case. The quantitative distribution of light in the spectrum, for example, varies widely both for a given light source and from light source to light source; yet no account has been taken of these variations in making determinations of comparative sensitivity. The relative sensitivity of the eye to the different colors has been estimated by comparing threshold and J.N.D. values expressed in terms of proportions of the total amounts of light used when no knowledge was had of these amounts, and the limits of sensitivity have been determined and compared for systematic purposes without any attempt at an equalization or even a consistent regulation of the physical quantities employed.

[2] Concerning the advisability of equalizing lights in terms of the color component they arouse in sensation for the purpose of determining the comparative sensitivities to different colors, Rand says in substance: (1) Stimuli should not be so equalized if one is to test the comparative sensitivity of the retina to the different colors. Such equalization begs the question at the outset. If the limits of sensitivity, for example, were to be determined with stimuli so equated for the central retina, the results obtained would not at all express the comparative limits for the colors in question. If these limits should be found to coincide, the conclusion could not be drawn either that the sensitivity of the retina to these colors extended only to this point or that there is equal sensitivity at this point to the colors used. At most no more could be said than that approximately the same ratio of sensitivity to the two colors obtain in this region that was present at the point in the central retina for which they were equated; but this ratio may not be a 1 : 1 ratio. In fact the investigator who gets his limits to coincide with stimuli so equated finds himself in the position of having made his conditions such that the limits could not help but coincide regardless of whether they ought to do so or not. He is not working with real limits, but with limits arbitrarily established, and the coincidence he finds is not a real coincidence, at least so far as he is able to determine by his method of working, but an artifact. (2) The stimuli especially should not be equated in terms of the cancelling-power of antagonistic colors. This method is anomalous. One scarcely knows what it does accomplish. On the one hand, stimuli so equated are in no way equated in physical intensity; and on the other hand, it would be the merest assumption to say that they have equal power to arouse sensation. To bear out the latter point Rand gives results comparative of the power of different colors to arouse sensation and to cancel their antagonistic color.

These same writers also equalized their stimuli in white-value for determining the comparative limits of sensitivity. Rand points out that they have not shown experimentally that the difference in the white-values of the colors employed affects the comparative limits of sensitivity, nor have they been able to get such evidence from the work of other investigators. Keeping the amount of colored light constant, she has made a determination of the amount of change that may be made in the white-values of the colors red, green, blue, and yellow of a given composition and amount, and has found that a much greater change may be made for each of these colors than exists between them at full saturation without affecting the limits of sensitivity. Fully aware of the quantitative effect of the achromatic upon the chromatic excitation from the results of previous investigations she has made along these lines, the author seeks to determine experimentally why such differences in the amount of the achromatic component of the excitation should have no effect upon the limits of sensitivity. She finds that sensitivity to color falls off very abruptly within the last 5° before the limits are reached. For example, to narrow the zone of sensitivity to color by 1°, it is found that for the stimuli used the amounts of colored light must be reduced from 24 per cent. to 37 per cent., varying with the color and to some extent with the meridian of the retina investigated; while the threshold 1° farther in is from 25 per cent. to 44 per cent. less even than it is at this point. It can thus be readily understood why a given amount of change in the white-value of a color may be of importance in making a threshold determination in the center of the retina and of no importance whatever in making a determination of the limits of sensitivity. Dr. Rand thus not only shows that there is no need of equalizing colors in white-value for making a determination of the comparative limits of sensitivity, but she points out two ways in which the equalization tends to defeat the purpose of the investigation. (1) The quality of certain colors is greatly changed when their brightness is altered, *i. e.*, a sensation is aroused, which has a color quality proper to a different range of wave-length. Moreover, the colors for which this qualitative change is greatest, namely, the blues and yellows, are those in which the greatest brightness change must be made to produce the equalization. And (2) the intensity of colors equated in brightness is necessarily much reduced; therefore, by means of them no comprehensive estimate of color sensitivity can be obtained.

The last eighty pages of the article are devoted to the report of a painstaking quantitative study and analysis of the effect on the retina's response to color of the brightness of the surrounding field, the preëxposure, the combined effect of preëxposure and surrounding field, and the general illumination of the field of vision. Methods of standardizing each of these factors[1] are described and a comparison is made of the experimenter's ability to reproduce results when these methods are employed and when no more precautions are taken than were used in previous work. In a long series of observations the author finds that for the former case she is able to duplicate the limits of sensitivity within 1°, and the limens of sensitivity at representative points in the peripheral retina within 2°–3°; while for the latter case the limits of sensitivity varied with 4°–6° and the limens of sensitivity from 60°–82°.

The author concludes her paper by pointing out that errors in the control of the factors that influence the response of the sense-organ and not errors in the judgment of the sensation aroused are apparently the cause of the large M.V. that has so long annoyed investigators of the color sensitivity of the peripheral retina. That is, before beginning her attempt to get a better control of the factors that influence color sensitivity, she had used all the psycho-physical precautions known to her to eliminate errors in judgment, still her inability to reproduce her results rendered, in her judgment, any accurate investigation of the sensitivity of the peripheral retina hopeless. On the other hand, with the control she has been able to get of the factors that influence the sensitivity of the retina to color and with only a comparatively rough observance of psycho-physical precautions, a very close reproduction of results has been rendered possible. With regard to work in the optics of color at least then, she is forced to conclude that the major source of error is not in the factors that influence the judgment but in those that influence the response of the sense-organ. Moreover, she would suggest that if in other sensory fields more attention were paid to the factors that influence the response of the sense-organ and relatively less to the factors that influence the judgment, a higher degree of precision may be attained in our methods of working.

[1] The standardization of the illumination of a room, for example, requires not only means of making small changes, but also a sensitive method of measuring or detecting these changes. The author describes a method of detecting changes in illumination which show a much greater sensitivity for daylight work than is possessed, for example, by equality of brightness photometers of the Sharp-Millar portable type. The method shows also high sensitivity for the photometry of lights of different color.

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VISION—COLOR DEFECTS

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Köllner (8) makes an important contribution to the literature of color defects. After a preliminary sketch of the facts of normal color-vision, Köllner gives a good general view of our present knowledge of the congenital defects of color-vision, following the customary German classification. Methods of diagnosis are suggested and a brief review given of the explanations of the facts of color blindness attempted by exponents of various color theories. The main body of the book is devoted to a detailed description of the *acquired* color defects. This field has been Köllner's specialty for a number of years, and his able treatment ought to make his book a standard volume for eye specialists. Köllner divides his discussion into 4 parts: (1) the general pathology of color-vision, comprising a thorough study of acquired blue-yellow, red-green and total color-blindness, colored seeing (perceiving colorless objects as though tinged with red, yellow, green or blue) and psychical color-blindness (color amnesia and color alexia); (2) the chief groups of disorders which cause or are accompanied by abnormal color-perception,—defects in the dioptric apparatus, diseases of the retina, the choroid, and the optic tract from retina to cortex, functional

and vasomotor neuroses, toxic conditions and abnormal states due to the abuse or exhaustion of the eye itself; (3) the best methods of testing color-vision in the fovea and the periphery; and (4) the implications to be drawn from the consideration of the facts of acquired color-blindness for a critique of color theories. Köllner's book is well integrated by the frequent use of cross references, furnished with excellent bibliographies of pertinent literature (though limited too exclusively to German publications), and well indexed.

In striking contrast to Köllner's work is Abney's book (1), in which the author has "brought together in book form the substance of a somewhat large number of communications which during the last 25 years he has made to the Royal Society, on the subjects of colour photometry and colour vision." Abney announces in his preface that one of the reasons for publishing his book was "his wish to show that the Trichromatic Theory of Colour Vision does not yet require a funeral oration over its remains," and a considerable part of the book reads like a lawyer's defense rather than an unbiased statement of facts. Pages 267–412 are devoted to an account of the author's own work on color defectives. Starting with the assumption that partial color-blindness is due to the loss of one of the three fundamental color sensations, the author seeks to show that the kind and degree of defect can be determined by measuring the luminosity of spectral colors in terms of white light, with which they can be equated in brightness by the use of the flicker method. Abney describes his color-patch apparatus, gives many luminosity curves and explains his method of calculating the various degrees of color deficiency. Abney seems unaffected by modern German and American work on color-vision and blandly assumes, for example, that a subject may lose his sensitiveness to red in various degrees without showing any deficiency in his sensitiveness to other colors, while white would appear to such a person as tinged with green, according to the form of the Helmholtz theory given in the first edition of the *Optik*. His color patch apparatus might be put to good use in a better cause. It is unfortunate that the author's personal influence was so great that the British Board of Trade Committee on Sight Tests in 1912 adopted Abney's method as the color test to be used on appeal, for the seaman will be quite as unwilling as the psychological critic to believe that a man's competency to "pick up colored lights" at sea can be determined by his "luminosity ratio,"—"the ratio of the brightness of a red (wave-

length 609 $\mu\mu$) to that of a green (wave-length 541 $\mu\mu$), divided by the value of this ratio for a person possessing normal vision."

Edridge-Green (3) reports that among men he has found 6 per cent. to be definitely color-blind and 25 per cent. defective in color-vision when compared with the other 75 per cent.; emphasizes (4) the necessity for using color names in testing for color-blindness; claims (5) that dichromates show such marked individual differences that it is better to arrange them in a series with transition forms, than to try to divide them into two distinct classes; strengthens his former claim that dichromates can often form the Rayleigh equation (yellow equals red plus green) as accurately as persons with normal color vision, by giving a case (6); and reiterates (5) his assertions that simultaneous contrast for red and green is increased in dichromatic vision, and that some subjects show loss of sensitiveness to red because of a shortening of the spectrum, without exhibiting any other color defect. Galloway (7) reports a case of this last type, investigated with wools and with Edridge-Green's lantern.

Armaignac (2) suggests an arrangement of colored wools inside a box, which permits the display of small amounts of color for the discovery of central color scotoma, and the ready increase of the area of stimulation at will.

Stilling (9) presents a new edition of his Pseudo-Isochromatische Tafeln, in which he has altered somewhat the arrangement of the plates to make it impossible for anyone to learn the test for the purpose of feigning color-blindness. And to these plates he has added four plates of colored letters printed on black, to be used as a general test of color perception, similar to the plates published by him in 1876. A general discussion of color defects, with directions for the use of the plates, is given in the introduction.

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HEARING

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Recent investigations dealing with the analysis of tones and vowels indicate the need of a more or less radical revision of some of the fundamental views of hearing. The most striking results reported during 1913 are probably those of Jaensch (4). This author has devised a unique synthetic method for the study of vowel sounds. He describes his apparatus as a *selenium siren.* The selenium cell is known to be very sensitive to light stimuli. The light to which the cell is exposed is furnished by a projection apparatus. To provide the conditions of a simple sine-wave of measurable vibration rate, a rotating disk with hatched edge is introduced between the source of light and the cell. Combinations of disks and modifications in the hatching provide all manner of complex vibratory stimuli. The cell is connected with a telephone-receiver whose membrane is set in vibration to produce the corresponding sound.

The net result of the investigation is that any disturbance in the regularity of a sine-wave gives a noise, but if the disturbance be sufficiently uniform to maintain an average value without too great a mean variation, a vowel sound is heard. These disturbances may be introduced in different ways. The addition of sine-waves of varying frequencies, which, however, preserve a constant average, changes the tone into a vowel sound. The same effect may be secured with a constant wave-length, by an alteration of phase in short intervals. Even superimposed curves in the ratio of 3 : 4 or 4 : 3 were found to give vowel character to the lower tone, which is at the same time intensified. As Rudolph Koenig first indicated, and recent investigators have clearly demonstrated, the principal vowels are distributed at intervals which approximate

octave distances. The peculiar pitch of a vowel is determined, then, by the average which all the single vibrations must approach. The vowel quality is clearest at a certain mean variation; beyond that it becomes obscured in a more or less undifferentiated noise.

The author concludes that the noise sense is distinct from the tone sense, and that vowels are the specific qualities of noise. He also contends that the sense of noise is genetically prior to the sense of tone, and that Köhler's results, which seemed to show that vowels are qualities of the tone sense, were erroneous. A pure tone, however, which has the vibration-frequency of a certain vowel, will resemble that vowel because of the fact that the tone sense, being more recent in the history of the race, also arouses at the same time more or less of the older and more fundamental noise character of sound. In the case of very low and very high tones, the musical quality and pitch are lost. There remain for these regions noises having the qualities of certain consonants, *m* for the low region and *s* for the high. The author upholds Hermann's "formant" theory together with the conclusion that the vowel sound and the tone upon which it is sung are in large measure independent phenomena. By his synthetic method he finds it possible to vary the vowel with constant pitch, and also to vary the pitch with a constant vowel.

Köhler (6) in a brief communication deals first with some observations on high tones which lead him to believe that the limit of hearing as set for 20,000 vibrations is too low. The *s*-sound is produced at about 8,400 vibrations. *f* appears an octave higher. He regards the latter as a pure tone since it can be eliminated by suitable interference apparatus. With yet higher frequencies, the *f* recedes and a *ch*-sound appears. Interference eliminates this up to 30,000 vibrations. If the octave law holds, we should expect this sound to occur with tones of 34,000 vibrations, at least, and probably vary on upwards so that the limit of hearing would fall between 34,000 and 68,000 vibrations. Confirmation for this view is found in the fact that pathological cases of deafness for high tones also indicate deafness for the consonants *s*, *f* and *ch*.

Although these results are in line with Köhler's well-known theory,[1] they do not seem to be necessarily at variance with Jaensch's contentions, since it is improbable that the interference tubes employed were adjusted with sufficient delicacy to eliminate the adjacent frequencies, which, on the Jaensch theory, are the true producers of the formants in question. It is therefore possible

[1] Cf. this journal, 1911, **8**, 96f.

that sounds heard above 20,000 vibration-frequency are no longer tones but noises.

Köhler's second note deals with the theory of clangs. His observations here bring him also into touch with Jaensch, though again unconsciously. He now finds that it is not alone the single partial corresponding to the vibration-frequency of the vowel which contributes to its appearance in a clang, but all the partials of a certain regional valence. Thus he finds that when *a* is sung on a fundamental of 340 vibrations, and all the partials save 1,050—the approximate pitch of *a*—are eliminated, the vowel tends towards *m*, but if 1,360 is permitted to remain, a very good *a* is possible. He concludes that the partials of a clang are relatively weak in a sung vowel. They do not remain side by side as individual components of the clang, but enter into a resultant totality. That which we are able to analyze out of the total clang is not the partial in its full individuality, but rather something left over from the combined totality, and of relative unimportance. In extenuation of these conclusions, a tentative theory is offered of the physiological processes involved. In this the author suggests that the resonators of the basilar membrane are not single fibers, but regional segments corresponding to the different vowel qualities. The intermediate tones between the vowel tones are thus produced by the combined activity of different resonators. A substantiation of these suggestions is sought in the work upon animals, where it has been shown that continued stimulation by certain tones destroys the organs of the cochlea, low tones attacking the tip and high tones the base of the membrane. The amount of destruction, however, has proven too great to be in full accord with the Helmholtz hypothesis. But if the resonators are not numerous, but few in number, this discrepancy is accounted for.

Baley (1) reports some interesting results which may be correlated with Köhler's theoretical suggestions. This investigator finds that several tones, differing by small but equal vibration-frequency, when simultaneously sounded, have a tendency to flow together into a single resultant tone, whose pitch is that of the arithmetic mean of the several tones. This tendency is so strong that, in the middle region of the scale, even ten tones embracing an interval of a half-tone may be thus united into one mean tone. The phenomenon occurs after a shock which lasts for a short time, and is dependent to some extent upon the position of the head. Yet even in unfavorable positions, the number of discriminable

tones is less than the actual number sounded. With the addition of tones on either side of a small interval, the impurity of the interval is not increased, although an unpleasant effect, due to the noisy and confused character of the complex sound, is experienced.

Révész (13), whose experiments with v. Liebermann were reported last year,[1] has since published a brochure in which the general bearings of his distinction of tonal quality and pitch upon music are given. Certain of his conclusions are in accord with Jaensch's views, since he finds the vowel series to be independent of both pitch and quality. v. Liebermann, who is deaf for quality in certain regions of the scale, still recognized without difficulty the vowels of this region, while another observer, who was quite deaf for tones above c^3, could still detect the vowels which occur at these pitches. He, therefore, also refutes Köhler's original view that vowel quality is the single characteristic of tones, and concludes that the tonal series is made up of three subsidiary series, namely, pitch, musical- and vowel-quality. Regarding "absolute pitch," he finds two distinct phenomena: absolute pitch in the true sense, and absolute quality. The first is acquired, the second is apparently innate, yet the first is found without the second, the second never without the first.

In his study of the musical interval, he finds both pitch and quality to be involved. Distance alone does not determine the interval, because the same interval in different regions of the scale gives an impression of different distances. In addition to pitch-distance there must also be a quality-distance, which he terms a "segment." Equal segments are not always equal intervals, because the segment remains the same when its qualities extend beyond the range of an octave. In successive tones the appearance of the interval is the foundation of melody. With simultaneous tones—harmony—pitch rather than quality is the more important factor, as the phenomen of "orthosymphony" has shown.

The painstaking experiments of v. Maltzew (9) deal with the reliability of judging successive intervals in the high and low regions of the scale. The common musical intervals were employed, and for the higher register they fell between c^3 and c^6. All were within the octave range, and were judged both as ascending and descending steps. Errors in judgment were found to increase progressively with increased pitch. Consonant intervals were judged with more reliability than dissonant intervals, except in

[1] Cf. this journal, 1913, 10, 107f.

the case of seconds, the larger intervals being less reliable and the errors more widely distributed than the smaller. Two kinds of error were prominent: (1) the confusion of neighboring intervals, which is most frequent when the interval is small; (2) the confusion of intervals having a similar degree of consonance.

A consideration of the parts played by fusion and distance in the judgments led to the conclusion that neither can be offered in explanation of the results. If it were chiefly a matter of either or both, there should be no marked difference in judging ascending and descending intervals, yet the latter are much less reliable than the former. The author infers, therefore, a qualitative individuality of musical steps, a content of interval which is not referable either to fusion or distance. This "Schritt- oder Übergangserlebnis" is in many ways identical with Révész's concept of the "segment." Marked tendencies were noted to substitute smaller for larger intervals, and familiar or frequent for unfamiliar or infrequent intervals. There was also discovered in the higher region a normal "false-hearing," which occasions confusion among common intervals such as the octave and major sixth. The reason is that the higher tone is heard at a lower pitch than it actually possesses. A perseverative tendency is also operative at times, which occasions the recurrence not only of certain tones, but also of certain intervals. In the lower region of the scale the errors were found to be of a similar nature, although the presence of overtones often added to the difficulty of making reliable judgments.

Kemp's investigation (5) dealt mainly with direct observations on simultaneous clangs, produced by the tonometer, in comparing groups of two and three with reference to their degree of fusion. The experience of fusion is defined as a characteristic, unanalyzable content. As secondary features are noted the unity of the experience and the incomplete analysis of the clangs involved. The main result of these experiments is the distinction of four principal characteristics which contribute to the experience of consonance, each of which possesses its own peculiar features. These are: fusion, sensory agreeableness (*sinnliche Wohlklang*), sensory conformity (*sinnliche Zusammenpassen*) and harmonic conformity (*harmonische Zusammenpassen*). It was possible for the observers to differentiate these and to establish differences in the order of musical intervals when their judgments were based upon these different points of view. The following table indicates these differences of order, the highest degrees being given first:—

Fusion	Sensory Agreeableness	Sensory Conformity	Harmonic Conformity
Fifth Fourth	Major Third and Major Sixth	Fifth Major Third and Major Sixth	Fifth and Major Third
Major Third	Fifth		Major Sixth and Minor Third
Sixths and Minor Third	Fourth Minor Sixth and Minor Third	Fourth Minor Third and Minor Sixth	Fourth and Minor Sixth

The complexity of the experience of consonance is further indicated by the following table, in which the Roman numerals, I., II., III., measure corresponding degrees:

	Fusion	Sens. Agr.	Sens. Conf.	Harm. Conf.
Fifth	I.	II.	I.	I.
Fourth	I.	III.	III.	III.
Major Third	II.	I.	I.	I.
Minor Third	III.	III.	III.	II.
Major Sixth	III.	I.	I.	I.
Minor Sixth	III.	III.	III.	III.

Experiments were then performed to compare the fusion value of two-tone and three-tone chords, and especially to test Külpe's law, that with equal degrees of fusion among the intervals of a chord, a higher total fusion is obtained when the more highly fused interval is lowest in the chord. Stumpf has contended that the fusion of an interval is not affected by the addition of a third tone. The difference between these authorities is adjusted, and both laws are found to be valid. Stumpf's law appears to be applicable to an "ideal" fusion, and its operation is approximated when the observer abstracts from the added tone. The effect of the third tone is, however, in accordance with Külpe's law when the abstraction is incomplete. With the attention directed to sensory agreeableness rather than to pure fusion, a change in the effect was always found when the third tone was added, irrespective of complete or incomplete abstraction, but the change was not the same as that which occurs when pure fusion is the standard of judgment. Since an added tone does not necessarily alter the fusion of an interval, but does, under the same conditions, invariably change its character of agreeableness, the conclusion is reached that feeling is not referable to the sensory components, as such. Stumpf's opinion that the agreeableness of chords is to be reckoned among the sensory feelings, is therefore questioned.

Waiblinger (**18**), in a brief article, elaborates a previous pronouncement that the constructive elements of modern European

music are the *fifth* and *major third*. In the major triad, *c-e-g*, the "tonic effect" is noted in the tendency of both *e* and *g* towards *c*. In the minor triad, *c-e♭-g*, *g* again tends towards *c*, but also towards *e♭*. This is held to account for the incomplete satisfaction, or "minor effect" in music. Both the scale and its various triads are then analyzed with respect to these "convergent" and "divergent" tendencies. It is found that in the major scale there occur four convergent and three divergent chords, while in the minor scale two are convergent and five divergent. Taken together, and eliminating identical triads, there appear to be four convergent and eight divergent three-tone chords. An attempt is then made to show that musical effects, both melodic and harmonic, are resolvable into these tendencies occasioned by the tonic effect. The analyses are somewhat difficult to follow, since they are expressed throughout in terms of the letters of the scale, rather than by a numerical notation to indicate the relationships involved.

Krüger (7) in a brief abstract summarizes his well-known theory of consonance, and criticizes some of the objections to it which have been raised by Lipps and Stumpf. "The fundamental phenomenon of all dissonance consists in the existence of a *mistuned unisone* at the bottom of the total acoustic complex." The chief objections to the theory are declared to rest upon the neglect of associative factors, which play a large part in the concrete perception of tonal combinations. The immediate perception of consonance and dissonance is not independent of absolute pitch. Psychologically speaking, consonance and dissonance seem to have originated within the limits of the human voice.

K. L. Schaefer (14) has reported five cases in which combination-tones were perceived after loss of the drum or middle ear apparatus. Difference-tones of every order and pitch, even the very low tones, can apparently be heard in the absence of the ear drum. In the author's opinion the seat of difference-tones is the oval window. Peterson (11), however, referring to Clemens Schaefer's conclusion (1910) that combination-tones may arise in the fluid of the inner ear, calls attention to the fact that he had reached this same conclusion and had published results in its support in 1907. He also notes that his experimental results have demonstrated that subjective combination-tones do not appear after the fundamentals, but simultaneously with them.

Meyer (10) considers Bocci's recent demand that more attention be given to the morphological peculiarities of the organ of Corti

in devising theories of hearing, and objects to the imputation that his theory is open to this criticism. In reply, he maintains that his theory, together with those of Bonnier and ter Kuile are the only ones truly founded upon morphological facts. The three may be regarded as essentially one theory, since all are based upon the ideas of Johannes Müller. After reviewing the contributions of Bonnier and ter Kuile, the author describes his own method of procedure, and defends the use of the mathematical analysis, which he has found to suit the facts of the case better than does the Fourier analysis. The next problem was to apply this method to the mechanical processes of the organs involved. It was found to be applicable to an inelastic, bendable rod, to one end of which a transverse wave-motion is conducted. In conclusion, he propounds nineteen questions and answers concerning the morphological peculiarities of the cochlear organs. Among the points taken up are several dealing with the arch of Corti. This arch, it is maintained, affords a skeletal support which adds strength to the membranous tissues. Furthermore, the widened membrane at the apex of the cochlea provides a greater stimulable area for increased intensities than would be otherwise possible. In accordance with the resonance theory, however, we should expect an opposite distribution of fibers. The advantage of a long canal is to furnish a greater capacity of analysis. Animals having a short canal probably distinguish only high and low tones. A canal without windows would still afford a seat of hearing; the addition of windows simply adds to the sensitivity of the organ.

Peterson (12) in a second article reviews the present situation with regard to conflicting theories of hearing, and concludes that the facts seem to demand a resonance theory of the type indicated by Helmholtz. Three specific objections to the Helmholtz theory are then considered. First, as to the intensity relations of combination-tones, it has been found that difference-tones are sometimes more intensive than their fundamentals. This, he believes, may be readily explained when the difference-tones in question occur at a pitch which is more frequently heard than that of the fundamental. Furthermore, two or more difference-tones often coincide to strengthen each other. The difference-tones which fall between the fundamentals are weak, because the lower fundamental, which is known to acquire increased intensity, obscures them. Second, as to the obliteration of tones by lower loud tones, this he finds to be very slight when the tones are conducted directly through the

skull. He therefore concludes that the interference ordinarily observed is largely physical, and external to the cochlea. Third, the perception of the direction of sound by means of phase-differences is referred to "some cortical region" which may take note "of a slight disparity in phase, so to speak, of the neural impulses from the two ears."

Goebel (3) reports experiments upon the prepared ear of a hen under microscopic examination. His results indicate that the acoustic activity of the fowl's cochlea is similar to that of the maculæ in mammals, and seems to present a link between the human maculæ and cochlea. The direct cause of stimulation in all such organs is to be sought in the transformation and displacement of a membrane (*Deckhaut*). Thus, the underlying hair-cells are stimulated. The inner papillæ of the basal membrane (*Grundhaut*), in which the hair cells are embedded, serve for high tones, and the outer ones for low tones. In addition, the cochlear region is in general more sensitive to medium and high tones, and the macular region to low tones.

Beyer (2) reports observations on patients with defects of the middle ear, and finds that even the lowest tones may be heard in the absence of the drum and ossicles, including the stirrup-plate. The intactness of the labyrinthine membranes is apparently the only absolute condition for the proper functioning of the cochlea. The middle-ear apparatus is regarded as a mechanism for subtle regulation of the labyrinthine water column. Schulze (15) supports the view that the ossicles vibrate with the fluid of the cochlear canal as a fixed or incompressible body, because the linear dimensions of the bones are so small, when compared with the wave-lengths of the more usually heard tones, and, furthermore, because the vibration-frequencies of the bones are so much greater than those of the highest tones. Kutvirt (8) investigated 198 new-born babes, mostly within ten minutes to twenty-four hours after birth. He estimates that three-fourths of the new-born react to sound within twenty-four hours. Acuity or weakness of hearing he finds to be in relation to the length and difficulty of birth.

Waetzmann's book (17) is said to give a careful review of the resonance theories of hearing, with special reference to the views of Helmholtz. It is chiefly the physical problems which are dealt with.

Urban's (16) audiometer, which may be mentioned in conclusion, has already been described by Seashore in this journal.[1]

[1] Cf. this journal, 1914, 11, p. 20.

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[1] For my references to the articles of Beyer, Kutvirt, Schaefer, Schulze, and Waetzmann, I am indebted to the review notices of H. Beyer and W. Köhler in the *Zsch. f. Psychol.*, 1913, **66**, 290–293, and of H. Keller in the *Arch. f. d. ges. Psychol.*, 1913, **28**, 129–130.

SPECIAL REVIEWS

Grundzüge der Psychophysiologie. Eine Darstellung der normalen generellen und individuellen Psychologie. ALFRED LEHMANN. Leipzig: Reisland, 1912. Pp. x + 742.

Our information regarding psychology is large but unsystematic. Mental events depend on complex groups of conditions and neglecting any one of them may entirely vitiate the result. Even those phenomena which are tolerably well understood cannot now be systematized, because this may be done on the basis of a theory only and there is no workable theory at hand. The current theories are of metaphysical significance only and do not furnish real psychological explanations. Lehmann thinks that the energetic view is the only one successful in this respect. Mental phenomena, according to this theory, are due to a peculiar form of energy which originates by the chemical transformations within the central organ of the nervous system, and which is subjected to all the laws of energy transformations. Psychological laws are, therefore, special cases of the general principles of energy transformations. As formulated today these laws are unduly simplified and are not more than the working basis of a future, more complete, theory. These views of the Danish scientist have been known since about 1901 and the present book is the outcome of their application to the entire field of psychology. There is no question that the energetic view is one of the most original and most interesting doctrines of today.

The scope of the book is limited to psychology of the normal adult. The data of child psychology are used only where they give a better understanding of the adult mind. The book is divided into four parts. In the first part mental phenomena in general and their relations to their physical and physiological accompaniments are studied. It begins with a statement of the mind-body problem and of the fundamental principles of energetics. Then follows a chapter on the reactions of the living organism and on the laws of energy transformations that apply to them. The fourth and last chapter of the first part deals with the nerves and the central organ. The anatomical part is very clear and it seems that the amount of anatomical information to be given has been very judiciously selected.

The chapter closes with a discussion of the energy transformations in mental and nervous work, as determined by calorimetric experiments, and of the author's theory of inhibition and reinforcement.

The second part has the title Psychophysics and deals with simple mental phenomena and their relations to external stimuli. Psychical elements are defined as mental phenomena which are not susceptible of further analysis. Of such elements Lehmann distinguishes two: sensations and feelings. The sensations are discussed under the headings: optical sensations, acoustic sensations, taste and smell sensations, dermal sensations and organic sensations. The latter is a term for a group of sensations which comprise kinæsthetic sensations and sensations due to vegetative functions of the organism. It is well known that the author has advanced many new views as to the psychology of sensations, and that is what this part really amounts to, so that one may be sure to find it interesting and stimulating reading.

The third part deals with the mutual influence of mental contents and is properly called psychodynamics. Lehmann distinguishes between psychodynamic processes and psychodynamic activities, the latter being characterized by an accompanying feeling of effort or activity. The psychodynamic processes take place either in the sense organ or in the central organ and consist either in reinforcement or inhibition. As an example of the first kind brightness and color contrast, and the ghost of a moving light are discussed at some length. After a discussion of central inhibition and reinforcement, association and reproduction are described as results of repeated reinforcement. Psychical activities are classified as attention, discrimination, relating processes, and combination. We may be allowed to mention the following detail of the presentation, because it may be useful for similar purposes. Lehmann, belonging to the visual type, describes his introspections while solving a certain mechanical problem. To the text is added a series of pictures of more or less diagrammatical character which give an excellent idea of the steps by which the solution was reached. It is a matter of course that this scheme cannot be used for people who belong to the verbal type, and that its usefulness is limited in work with subjects who belong to the mixed type, but the assistance of some such scheme will be very welcome in all the cases where complicated introspections have to be digested.

The discussion of psychic complexes is the topic of the fourth part. By this term Lehmann refers to certain complex contents

which have the same essential features in all normal individuals. They do not correspond to external stimuli but develop in consciousness on the basis of experience. Time and space, the ego, emotions and volitions belong to this group.

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Encyclopædia of the Philosophical Sciences. Volume I. Logic. ARNOLD RUGE, WILHELM WINDELBAND, JOSIAH ROYCE, LOUIS COUTURAT, BENEDETTO CROCE, FEDERIGO ENRIQUES, and NICOLAJ LOSSKIJ. Translated by B. ETHEL MEYER. English editor, HENRY JONES. London: Macmillan and Company, 1913. Pp. x+270.

One of the distinctive merits of this initial volume lies in its reflection of the modern spirit of interest in and respect for widely divergent and even contradictory modes of thought. It would probably be difficult to find two more radically antithetic positions than those taken by Couturat in "The Principles of Logic" and by Croce in "The Task of Logic." The former writes with an eye single to the exposition of recent developments of symbolic logic, or what he prefers to designate as algorithmic logic, or logistics, a practical application of which science would be the elaboration of a language truly international and rational. The latter begins his paper with an attack on the futility and remoteness of the essentially scholastic activities of the logisticians, and then turns to a comprehensive statement of logic as neither a complex of rules nor a branch of psychology but as philosophy, or philosophical logic, conceived in the Hegelian spirit.

Again, in the paper on "The Problems of Logic" by Enriques, which may be characterized as an expression of critical positivism, the task of reason, that to which logic applies, is to draw together into a synthesis reality and spiritual elements, already given and awaiting one another; whereas in the paper on "The Transformation of the Concept of Consciousness in Modern Epistemology and Its Bearing on Logic" by Losskij synthesis is conceived of as having taken place in the object; the reasoning activity can be only analytic. Thus for the latter writer logic, having investigated the grounds on which the relation between the subject and object of a judgment is based, is concerned only with the objective, or synthetical, side. "Analysis, which . . . is the subjective work of the individual knowing, and only serves as a bridge to the objective side of judg-

ment, is of importance for Psychology, but not for Theory of Knowledge."

Windelband ascribes more importance to the psychological phases of logic than any one of the other contributors. He treats of theoretical, genetic, and social aspects of psychology as furnishing indispensable preparation for any logical inquiry and theory; it is necessary to study the genetic process which produces the feeling of the truth value. He states his agreement with the pragmatist that psychogenetically truth has no primary value for mankind, but "like all the results of civilization it attains value by means of many media, and, in accordance with a general law, begins as means and becomes an end in itself." In this preliminary tracing of the development of the truth value the sphere of the individual conscious life is overstepped, and "the socio-psychological presuppositions of Logic" become involved. Windelband brings out with great clearness and suggestiveness, but all too briefly, the important point that "perceiving and knowing as empirical functions are entirely social in their nature." He suggests also that the logical concepts of validity and of universality root in the judgments of a social community. Again, the "social character of cognition . . . shows itself above all in the fact that it finds its expression in *speech*, as the most characteristic vehicle of common life."

Yet all of this, in Windelband's treatment, is merely preliminary. Pragmatism, "mit allen seinen Deklamationen," is allowed to occupy but a "niche in the entrance porch of Logic." Even theoretical psychology can furnish no psychological principles of logic. By theoretical psychology Windelband clearly means that type of psychogenetic inquiry which aims to analyze the always complex content of conscious experience into its originally simple elements. It is this type of psychology which obviously does afford Windelband the warrant to say: "The decision of all these genetical problems, however, while for the Idealogist a matter of life and death, and for Theoretical Psychology of the greatest significance, is for Logic itself quite irrelevant; for Logic is concerned not with the origin but with the validity or truth of ideas." For it is a type of psychology that was preoccupied with "impressions" and ignored the expressive or motor functions. It was a psychology without hands. That is not the case, however, with recent developments in functional and social psychology, so appreciatively referred to by Windelband. It is difficult, if not impossible, to reconcile his recognition of their logical significance with the position he assumes when

he proceeds to develop a positive logical theory. They then are deemed to afford materials only; whereas logical theory "must start from the most general character of the theoretic consciousness. We find this in Kant's *principle of synthesis*."

One of the most significant points in Royce's profoundly suggestive paper on "The Principles of Logic," a paper which is concerned mainly with an elaborate treatment of the "Theory of Order," may be referred to in this connection. It is the point that our modes of action are subject to the same general laws as those to which propositions and classes are subject, and may be viewed "as a system within which the principles of logical order must be regarded as applicable." The so-called algebra of logic which may be applied to them becomes a calculus of modes of action, infinitely rich in ideal possibilities. The position here taken with reference to the existence of certain modes of activity and certain laws of the rational will, which are unescapably apriori conditions even of attempting to presuppose that they do not exist, is characterized as "absolute pragmatism" (as if the saving grace and most dearly cherished attribute of pragmatism were not its essential relativity!).

What are these "modes of activity" but the expressive and motor aspects of conscious organic life, ignored by the traditional psychogenetic type of analysis, and then seized upon and abstracted from immediate experience by the logician or philosopher, to reappear now in the guise of a synthetic principle, now as the concept of validity, and now as an ideal system of Absolute Pragmatism?

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Thought and Things: A Study of the Development and Meaning of Thought, or Genetic Logic. Volume III, Interest and Art, being Real Logic; I, Genetic Epistemology. James Mark Baldwin. London: George Allen & Company. New York: The Macmillan Company, 1911. Pp. xvi+284.

It would be difficult to disentangle the purely psychological considerations developed in this volume. One of the virtues of the work doubtless lies precisely in the interpenetration of psychical, logical, ethical, and æsthetic "thoughts and things." Of the psychology involved it may be said in general that it is genetic not only as to its subject matter, but also as to its method; it may be recognized as the method of interpretation first developed in the

volumes on *Mental Development* and now come to its maturity. In the features of the adult form we may observe a likeness to the earlier traits of its childhood and youth,—a sort of "semblant revival."

This volume is devoted in the main to a detailed study of the logic of the ethical and the æsthetic experiences; and it culminates in the statement of a philosophical programme to be known as "Pancalism," the full treatment of which is postponed to the forthcoming and final volume. On the psychological side it is apparent that the concept of the bi-polar self of the *Social and Ethical Interpretations*—the self of habit and of accommodation, of self-assertion and of imitation—continues to play a leading rôle. The logic of this concept is in control, apparently, throughout the greater part of the discussion. Like every working concept it is, of course, an abstraction; and is not open to criticism on the ground that it does not contain a full representation of the reality to which it refers. It may be considered as involved instrumentally in at least four phases of the present discussion:

1. It answers adequately to the paganly non-moral "give and take" of unequal social selves, where self-assertion and imitation function alternately.

2. It answers adequately, also, to that æsthetic experience (but conceivably non-artistic expression) in which both self-exhibition and imitation function together under the influence of some "make-believe," some "semblance," some "livslögnen," which sets free and harmonizes the bi-polar self as a whole.

3. It does not answer adequately to the true moral experience, as distinguished alike from conformity to social habit and from following individual inclination. The bi-polar self is a self of arrested development, as is clearly seen when it is brought face to face with a moral situation. It is a self incapable of generating a moral ideal. A miracle is invoked: Let the "ought" arise out of the "must!"

4. It seems to be responsible, in part at least, for the statement of an irreconcilable dualism of logic and ethics. The contrast between logical necessity and moral necessity, according to Professor Baldwin's account, could not be more marked than it is. Logic is conceived of as concerned with the necessity of establishing the whole in the world of ideas, and of separating it positively from any further control by fact. "So far as it becomes formal and logical, a body of theoretical intuition ceases to be material and experi-

mental, a body of growing and inductive knowledge. The mediating body of ideas is taken to be a detached and self-sufficient system of absolute truths." In the case of the moral ideal, on the other hand, no rules of consistency are presented. "Instead of a body of relational contents, there is an attitude of will, a motive of personal choice, a movement of determination of the self upon a practical problem which allows alternative solutions" (p. 136). "In the one, *the end is lost in the means;* in the other; *the means is lost in the end. Each thus attains its normal (!) ideal*" (p. 133).

On such a tragic ending as this we may well be thankful to have the author ring down the painted curtain of "Pancalism."

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DISCUSSION

NOTE ON A CASE OF CHROMÆSTHESIA

The following data are submitted in order to add to the evidence already offered by Galton, Calkins, Pierce, Claparède, Dresslar and others in regard to the permanence of the association in cases of synæsthesia and to show the effect on the colors of the combination of tones, with special reference to complementary colors.

The subject was a young talented woman musician and composer, who was twenty-three at the time of the first investigation, which was made in January, 1905. A second investigation was conducted seven and a half years after the first. The subject could name the color, in fact could see the color at the mention of the musical note. At times however she also struck the note on the piano. The colors were seen as light similar to the colored illumination of the stage. This differs from the case reported by C. S. Myers[1] in which the subject thought rather than saw the colors. The color was the same as to hue for a given tone in all parts of the scale. It changed, however, as to luminosity, being bright in the higher and dark in the lower register. In this respect there is also a difference from Myers's subject, who saw different colors with a change in pitch. The phenomenon has been present as far back as the subject can remember. She began to play the piano shortly before the age of three and distinctly remembers seeing the colors then.

Some of the associations are as follows:

	1905	1912
c	red	red
d♭	purple	lavendar
d	violet	violet
e♭	soft blue	thick blue
e	golden yellow	sunlight
f	pink	pink, apple blossoms
f♯	green blue	blue green
g♭	greener blue	greener blue
g	clear blue	clear sky blue
a	cold yellow	clear yellow, hard, not warm
b♭	orange	verges on orange
b	very brilliant coppery	very brilliant coppery

[1] "A Case of Synæsthesis," *Brit. Jour. of Psych.*, 4, 1911, pp. 228–238.

It will be seen that there is almost perfect agreement between the two investigations. The subject assured me that she had never given any thought to the investigation in the interim.

In December, 1913, investigations were made in regard to the combination of tones. When those tones were chosen which corresponded rather closely to the complementary colors the results were as follows: c (red) and f# (green blue) gave a very indefinite light verging on gray. Red came up at times. G (clear blue) and a (cold yellow) called forth a hazy mist like the other only this time yellow and blue came up at times. The subject upon being questioned expressed total ignorance of the properties of complementary colors. That the fusion is not complete is not surprising when one recalls the fact that in musical fusion the separate notes can be heard as well as the resulting chord.

In chords such as for example c e g the color of the fundamental predominates. In fact in all triads it is the color of the fundamental note which prevails. In dissonances the colors are paler, as if there was a veil over them. In the altered chords no one color predominates. There is no fusion, the different colors flashing up more or less together. The dominant seventh and ninth are not so hazy. They take on the color of the fundamental note, but the other colors keep coming up.

In conclusion it may be stated that the subject did not have any other form of synæsthesia, which fact seems to disprove Myers's statement that "it is probable for the full development of synæsthesia a strong tendency to a certain kind of association is requisite." Myers's subject formed associations between colors and words, the days of the week, etc. A comparison of the two cases seems to indicate that the chromæsthesia here recorded is entirely of physiological origin, while Myers's case started perhaps from some physiological predisposition and developed through chance associations. A third type of associations frequently reported and one to which the term synæsthesia should not be applied is where the associations are entirely the result of the experience of the individual, in most instances through the mediation of feeling tone.

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BOOKS RECEIVED

Hunt, E. L. *Diagnostic Symptoms in Nervous Diseases.* Phila. & London: Saunders, 1914. Pp. 229. $1.50 net.

Dercum, F. X. *A Clinical Manual of Mental Diseases.* Phila. & London: Saunders, 1914. Pp. 425. $3 net.

Coffin, J. H. *The Socialized Conscience.* Baltimore: Warwick & York, 1913. Pp. viii + 247.

Blondel, C. *La Conscience morbide, Essai de psycho-pathologie générale.* Paris: Alcan, 1914. Pp. 336.

Kleinpeter, H. *Vorträge zur Einführung in die Psychologie.* Leipzig: Barth, 1914. Pp. vi + 435. M. 6.60; M. 7.50 geb.

Fiske, E. W. *An Elementary Study of the Brain.* New York: Macmillan, 1913. Pp. vii + 133.

NOTES AND NEWS

Arthur Henry Pierce, professor of psychology at Smith College and editor of the Psychological Bulletin died on February 20 after a short illness. His colleagues on the editorial board of the Review Publications are deeply sensible of the loss sustained by these magazines and American psychology generally. Dr. Pierce was an efficient and tactful collaborator, and a man of unusually charming personality.

About 30 pictures of psychologists have been procured by Dr. E. A. Kirkpatrick of Fitchburg, Mass., in accordance with the plans suggested in the Bulletin some months ago.

Professor Thomas H. Haines, of Ohio State University, who is on leave of absence, is conducting the courses in psychology at Smith College during the present semester.

The New York Branch of the American Psychological Association held its mid-year meeting at Princeton on February 23.

Dr. Livingston Farrand, who was secretary of the American Psychological Association, 1896–1904, entered upon his duties as President of the University of Colorado February 1.

The following items are taken from the press:

Dean James R. Angell, head of the department of psychology at the University of Chicago, will be the next Convocation Orator at the university.

Professor Joseph Jastrow, of the University of Wisconsin, gave the opening Convocation address at the University of Missouri on February 4, on "Theory and Practice."

Dr. Edward K. Strong, Jr. has been appointed professor of psychology and educational psychology at the George Peabody College for Teachers.

Mr. H. G. Childs, professor of educational psychology in the Brooklyn Training School for Teachers, has accepted an appointment to the chair of educational psychology in the University of Indiana.

Dr. Robert H. Gault of Northwestern University has been promoted from assistant professor to associate professor of psychology.

Dr. George R. M. Wells, of Oberlin College, has been advanced to an associate professorship of psychology.

"Practical Applications of Psychology" was the subject of an address by Professor J. R. Angell, of the University of Chicago, delivered on January 6 in the Fine Arts Theater, Chicago, under the auspices of the University Lecture Association.

Note.—Until further notice it is requested that all MS. intended for the Psychological Bulletin, announcements and notes, proof, editorial correspondence, and books offered for review, be sent to Professor Howard C. Warren, Princeton, New Jersey.